Electronic Version

Stylesheet Version v1.1.1

Description

[LIQUID CRYSTAL DISPLAY PANEL AND METHOD OF FABRICATION THEREOF]

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority benefit of Taiwan application serial no. 93100862, filed January 14, 2004.

BACKGROUND OF INVENTION

[0002] Field of the Invention

[0003] The present invention relates to a liquid crystal display panel and a method of fabrication thereof, and more particularly to a liquid crystal display and a method of fabrication thereof for reducing light leakage at edges of bezel of a liquid crystal display module.

[0004] Description of Related Art

[0005] Liquid Crystal Display (LCD) has advantages, such as small size, low weight, low driving voltage, low power consumption, and portability. Itwas applied in the display of the portable terminal system during the past twenty years

and widely used.

[0006] A One Drop Fill (ODF) process is adapted for fabricating a large-panel LCD display in which amount of the liquid crystal material can be properly controlled for reducing the fabrication costs. Further, the ODF process is capable of substantially reducing the process time to fill liquid crystal. Therefore, the ODF process can be meaningfully applied for mass-production LCD display.

[0007] In a typical ODF process, a radiation-curable adhesive is coated over a thin film transistor array substrate or over a color filter film substrate to form a sealed area. Then the liquid crystal is dropped into the sealed area. The thin film transistor array substrate is attached to the color filter film substrate. Finally, the resulting structure is exposed to, for example, a UV light, for hardening the radiation-curable adhesive and thereby bonding the substrates.

[0008] FIG. 1 is a cross-sectional view showing a prior art liquid crystal display module formed by using the ODF process. For simplification, FIG. 1 shows only the essential elements of an LCD display. Referring to FIG. 1, the liquid crystal display module comprises: a thin film transistor array substrate 102, a color filter film substrate 104, a black matrix layer 106, a sealant 108, a liquid crystal layer

110, polarizers 112 and 114, and a bezel 116. The black matrix layer 106 is disposed over the color filter film substrate 104. The sealant 108 is disposed between the thin film transistor array substrate 102 and the color filter film substrate 104. The liquid crystal layer 110 is disposed in the sealed space formed by the thin film transistor array substrate 102, the color filter film substrate 104 and the sealant 108. The polarizers 112 and 114 are separately disposed over the surfaces of the thin film transistor array substrate 102 and the color filter film substrate 104 such that the polarizers 112 and 114 do not contact the liquid crystal layer 110. The bezel is disposed over the polarizer 112.

[0009] The sealant 108 is hardened by exposing the sealant 108 to the UV light during the ODF process, and therefore it is important that the black matrix layer 106 does not block the sealant 108. Moreover, the ODF process requires that the black matrix layer 106 over the color filter film substrate 104 should be separated from the sealant 108 with a distance as shown in FIG. 1.

[0010] Today, the process of fabricating the liquid crystal display panel/module should fit the Standard Panel Work Group (SPWG) specification. Despite the LCD display is being fab-

ricated using the ODF process fitting the SPWG specification, light leakage 120 will invariably occur at the edges of the bezel 116 at about the view angle 45° as shown in the magnified view of part A.

[0011] Some prior art proposed to extend the black matrix layer 106 to outside. But to fit the SPWG specification, the dimension of the liquid crystal cell should be increased. Accordingly, the notebook computers cannot satisfy the SPWG specification.

SUMMARY OF INVENTION

[0012] The present invention is directed to a liquid crystal display panel and a fabrication method thereof, for reducing the light leakage of the liquid crystal display module.

[0013] The present invention is directed to a liquid crystal display panel and a method of fabrication thereof using the ODF process fitting the SPWG specification. Further, the light leakage of the liquid crystal display module fabricated using the ODF process can be reduced.

[0014] According to an embodiment of the present invention, the liquid crystal display panel comprises a first substrate; a second substrate; a sealant, disposed between the first substrate and the second substrate; a liquid crystal layer, disposed among the first substrate, the second substrate

and the sealant; and a light-shielding layer, disposed over a surface of the first substrate such that the light-shielding layer does not contact the liquid crystal layer.

[0015] According to an embodiment of the present invention, the method of fabricating the liquid crystal display panel comprises, first, a first substrate and a second substrate are provided. Next, a sealant is formed over a surface of the first substrate. Next, a liquid crystal layer is filled into the sealant formed over the surface of the first substrate. Next, the first substrate is attached onto the second substrate. Next, the sealant is exposed to a light. Thereafter, a light-shielding layer is formed over a surface of the first substrate such that the light-shielding layer does not contact the liquid crystal layer.

[0016] According to an embodiment of the present invention, the material of the light-shielding layer comprises, for example but not limited to, an ink or a black ink.

[0017] According to an embodiment of the present invention, the optical density of the light-shielding layer is, for example but not limited to, 2.0 or more than 2.0.

[0018] According to an embodiment of the present invention, the liquid crystal display panel comprises a display area, and the light-shielding layer is disposed over a peripheral area

outside the display area of the first substrate.

[0019] According to an embodiment of the present invention, the light-shielding layer is formed over the substrate of the liquid crystal display panel. When the liquid crystal display panel is applied in an electronic product, the light-shielding layer is capable of reducing the light leakage at the bezel edge of the liquid crystal display module.

[0020] According to an embodiment of the present invention, the light-shielding layer is formed over the substrate after the sealant is hardened. The liquid crystal display panel can be fabricated by using the ODF process fitting the SPGW specification. Further, the light leakage of the liquid crystal display module fabricated by the ODF process can be reduced.

[0021] In order to make the aforementioned and other objects, features and advantages of the present invention understandable, a preferred embodiment accompanied with figures is described in detail below.

BRIEF DESCRIPTION OF DRAWINGS

[0022] FIG. 1 is a cross-sectional view showing a prior art liquid crystal display module fabricated by using an ODF process.

[0023] FIGS. 2A-2D are cross-sectional views showing progres-

sive process steps of a ODF process of fabricating a liquid crystal display panel according to an embodiment of the present invention.

[0024] FIG. 3 is a top view of the liquid crystal display panel shown in FIG. 2D.

[0025] FIG. 4 is a cross-sectional view showing a liquid crystal display module fabricated using an ODF process according to an embodiment of the present invention.

[0026] FIG. 5 is a cross-sectional view showing a liquid crystal display panel fabricated using an ODF process according to an embodiment of the present invention.

[0027] FIG. 6 is a cross-sectional view showing a liquid crystal display module fabricated using an ODF process according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0028] FIGS. 2A-2D are cross-sectional views showing progressive process steps of an ODF process of fabricating a liquid crystal display panel according to an embodiment of the present invention. For simplification, the figures show only the essential elements.

[0029] Referring to FIG. 2A, a first substrate 202, for example but not limited to, a plastic substrate or a glass substrate, is provided. Next, a thin film transistor array (not shown) is

formed over the substrate 202 to form a thin film transistor array substrate.For example, each transistor comprises a channel region comprised of α-Si, Poly-Si, orthe like.

[0030] A second substrate 204, for example but not limited to, a plastic substrate or a glass substrate, is provided. A color filter film (not shown) is formed, for example, directly on the substrate 204, or the color filter film is formed first and thenapplied on the substrate,to form a color filter film substrate. A black matrix layer 206 is formed over the second substrate 204. The sealant 208 is coated over the substrate 202 to form a sealed area, wherein the sealant 208 can be, for example but not limited to, a radiation-curable adhesive.

[0031] Referring to FIG. 2B, liquid crystal is dropped into the sealed area to form a liquid crystal layer 210. Referring to FIG. 2C, the first substrate 202 is attached to the second substrate 204. UV light is applied through the edges of the substrate 204 to harden the sealant 208, and thereby attach the first substrate 202 onto the second substrate 204.

[0032] Referring to FIGS. 2D and 3, wherein FIG. 3 is a top view of the liquid crystal display panel shown in FIG. 2D. A light-shielding layer 214 is formed over a surface of the sub-

strate 204 such that the light-shielding layer 214 does not contact the liquid crystal layer 210. As shown in FIG. 3, the light-shielding layer 214 is disposed over a peripheral area outside the displayer area 230 of the liquid crystal display panel. In an embodiment of the present invention, the light-shielding layer 214, for example, surrounds the display area 230 and has a frame shape. Thereafter, a liquid crystal display panel comprising the light-shielding layer 214 is fabricated according to the process steps described with reference to FIGS. 2A-2D.

[0033] According to an embodiment of the present invention, the light-shielding layer 214 is formed by using materials, for example,having an optical density of about 2.0 or higher than 2.0. The material of the light-shielding layer 214 comprises, for example but not limited to, ink, which can be formed, for example, by using an ink jet printing method, a screen printing method or a gravure printing method. Moreover, according to an embodiment of the present invention, the light-shielding layer 214 is capable of shielding the light, and the ink is, for example but not limited to, a black ink.

[0034] FIG. 4 is a cross-sectional view showing a liquid crystal display module fabricated using an ODF process accord-

ing to an embodiment of the present invention. For simplification, FIG. 4 shows only the essential elements. Referring to FIG. 4, the liquid crystal display module comprises the liquid crystal display panel of FIG. 2D, polarizers 216 and 218, and a bezel 220. The liquid crystal display panel comprises the first and second substrates 202 and 204, the black matrix layer 206, the sealant 208, the liquid crystal layer 210 and the light-shielding layer 214.

[0035] According to an embodiment of the present invention, the black matrix layer 206 is disposed over the substrate 204, the sealant 208 is disposed between the first and second substrates 202 and 204, and the liquid crystal layer 210 is disposed in the sealed space among the first and second substrates 202 and 204 and the sealant 208. The light-shielding layer 214 is disposed over another surface of the substrate 204 such that the light-shielding layer 214 does not contact the liquid crystal layer 210. The light-shielding layer 214 is disposed over the peripheral area outside the display area (not shown) of the liquid crystal display panel. The optical density of the light-shielding layer 214 is, for example but not limited to, 2.0 or more than 2.0. The material of the light-shielding layer 214 can be, for example but not limited to, ink and the ink can be,

for example but not limited to, a black ink.

[0036] According to an embodiment of the present invention, the light-shielding layer 214 projectingly overlaps the edge of black matrix layer to reduce the light leakage. The width of the light-shielding layer 214 may extend toward an edge of the first and second substrates exposing at least a portion of the sealant depending on the hardening process.

[0037] Referring to FIG. 4, the polarizers 216 and 218 are separately disposed on the surfaces of the first and second substrates 202 and 204 such that the polizers 216 and 218 do not contact the liquid crystal layer 210. The polarizer 216 is disposed over the second substrate 204 covering the light-shielding layer 214. The bezel 220 is disposed over the polarizer 216 covering a part of peripheral area of the liquid crystal display panel.

[0038] When the exemplary liquid crystal display panel comprising the light-shielding layer of FIG. 2D is applied to the liquid crystal display module, because the light-shielding layer 214 is disposed over the substrate 204, the light leakage 240 can be shielded by the light-shielding layer 214 as shown in the magnified view of the part B. Therefore, the light leakage at the edges of the bezel 220 of the

liquid crystal display module can be effectively reduced.

[0039] In the embodiment described above, the light-shielding layer 214 is disposed over the substrate 204 (the color filter film substrate). However, the present invention present is limited to the embodiment described above. FIG. 5 is a cross-sectional view showing a liquid crystal display panel formed using an ODF process according to another embodiment of the present invention. The elements of the liquid crystal display panel in FIG. 5 are similar to the liquid crystal display panel in FIG. 2 with the same reference numbers and the detail descriptions thereof will not be repeated hereinafter.

[0040] Further, the structure of the liquid crystal display panel in FIG. 5 is similar to that in FIG. 2D except for the light-shielding layer 250 is disposed over another surface of the first substrate 202 (the thin film transistor array substrate) and not in contact with the liquid crystal layer 210. The liquid crystal display panel can be fabricated using the process steps with reference to FIGS. 2A-2C described above. Further, the light-shielding layer 250 can be, for example, fabricated using a process similar to that used for fabricating the light-shielding layer 214. The light-shielding layer 250 can be, for example, disposed over

the peripheral area outside the display area 230 of the liquid crystal display panel. In this embodiment, the light-shielding layer 250, for example, surrounds the display area 230 and in a shape of a frame.

[0041] FIG. 6 is a cross-sectional view showing a liquid crystal display module fabricated using an ODF process according to another embodiment of the present invention. In this embodiment, the liquid crystal display panel shown in FIG. 5 is utilized to fabricate the liquid crystal display module. It should be noted that elements of the liquid crystal display panel in FIG. 6 are similar to those in FIG. 4 and have the same reference numbers and the detail descriptions are not repeated hereinafter. The structure of the liquid crystal display panel shown in FIG. 5 is similar to that shown in FIG. 4 except for the light-shielding layer 250 is disposed over another surface of the substrate 202 not in contact with the liquid crystal layer 210. Further, because the material and location of the light-shielding layer 250 are similar to those described in FIG. 5, detail descriptions thereof are not repeated hereinafter.

[0042] When the liquid crystal display panel comprising the light-shielding layer of the present embodiment (FIG.5) is applied to the liquid crystal display module, because the

light-shielding layer 250 is disposed on the substrate 202, the light 260 emitted from backlight module (not shown) can be shielded by the light-shielding layer 250 as shown in FIG. 6. In other words, the surface of the substrate 202 can shield the light leakage outside the display area 230. Therefore, the light leakage at the edges of the bezel 220 of the liquid crystal display module can be effectively reduced.

[0043] In an embodiment of the present invention, the thin film transistor array substrate comprises, for example but not limited to, bottom gate thin film transistors. However, the present invention is not limited thereto. According to an embodiment of the present invention, a low-temperature polysilicon thin film transistor process or any other active matrix liquid crystal display process may be applied for fabricating the liquid crystal display panel.

[0044] According to an embodiment of the present invention, the ink of the light-shielding layer is a black ink. However, the present invention is not limited thereto. Alternatively, the color of the ink can be of any color as long as the color of the ink can effectively shield light.

[0045] According to an embodiment of the present invention, the sealant is disposed over the first substrate 202 (the thin

film transistor array substrate). The liquid crystal layer is formed over the substrate 202 within the sealed space surrounded by the sealant. However, the present invention is not limited thereto. The sealant 208 can be formed over the second substrate 204 (the color filter substrate). The liquid crystal layer is formed over the second substrate 204 within the sealed space surrounded by the sealant.

[0046] According to an embodiment of the present invention, the black matrix layer is disposed over the substrate 204 (the color filtersubstrate). After the first substrate 202 is placed onto the second substrate 204, the edges of the substrate 204 are exposed to light to cure the sealant comprising the radiation-curable adhesive. However, the present invention is not limited thereto. The black matrix layer can also be disposed over the substrate 202 (the thin film transistor array substrate). Moreover, as long as the light-shielding layer shields leakage light, the black matrix can be disposed over the same substrate or over different substrates.

[0047] Furthermore, the light-shielding layer comprises ink, however the present invention is not limited thereto. As long as the light-shielding layer is disposed over another surface of the substrate not in contact with the liquid

crystal layer fabricated using the ODF process, it is considered to be within the scope of the present invention.

[0048] Accordingly, the present invention has following advantages: 1. The liquid crystal display panel of the present invention has the light-shielding layer formed over the substrate. When the liquid crystal display panel is applied to the electronic product, the light-shielding layer is capable of shielding the leakage light at the edges of the bezel of the liquid crystal display module and thereby reducing the light leakage from the liquid crystal display module. 2. As to the method of fabricating the liquid crystal display panel using the ODF process, the light-shielding layer is formed on the substrate after the liquid crystal display panel is exposed to a light for hardening the sealant. The liquid crystal display panel can be fabricated using the ODF process fitting the SPGW specification, and also reduce the light leakage issue of the liquid crystal display module.

[0049] Although the present invention has been described in terms of exemplary embodiments, it is not limited thereto. Rather, the appended claims should be constructed broadly to include other variants and embodiments of the invention which may be made by those

skilled in the field of this art without departing from the scope and range of equivalents of the invention.